

# AR7030

## Additional operating information for FPU7030 and NB7030 options.

### 1 Contents

<b>2 Introduction and options</b> .....	<b>1</b>
2-1 Overview	
2-2 Memory idents	
2-3 New timers	
2-4 Noise blanker	
2-5 Notch filter	
2-6 Menu structure	
<b>3 Configuration menu</b> .....	<b>3</b>
3-1 New entries	
3-2 Setting up the NB7030 option	
<b>4 Memory extensions</b> .....	<b>4</b>
4-1 More memories	
4-2 Text identification	
4-3 Ident preview	
4-4 Ident search	
4-5 Memory editor	
4-6 Memory indexing	
<b>5 Timer extensions</b> .....	<b>6</b>
5-1 Setting the clock time and date	
5-2 Timer operation	
5-3 Setting the timers	
<b>6 Noise blanker operation</b> .....	<b>7</b>
6-1 Option configuration	
6-2 Noise blanker operation	
6-3 Noise blanker menu	
<b>7 Notch filter operation</b> .....	<b>7</b>
7-1 Option configuration	
7-2 Notch filter operation	
7-3 Notch filter menu	
<b>8 Option specifications</b> .....	<b>8</b>

## 2 Introduction and Options

### 2-1 Overview

This supplement to the AR7030 Operating Manual covers the functional changes and extensions that are due to the enhanced processor (FPU7030). The enhanced processor is required to operate the Notch Filter and Noise Blanker options, but a receiver without the NB7030 option board may still use the enhanced processor to gain extra memory and timer functions.

The standard AR7030 manual covers the operating principles of the receiver and these remain largely unchanged with the enhanced processor. New users should use the standard manual to become familiar with the set, referring to this supplement if there seems to be a discrepancy between the manual and the receiver's behaviour. Experienced users should find that the new features fit quite seamlessly into the operating method, although some functions may have moved or require an extra button press now.

The next few sections give an outline of the new features and the terms used for them. Of particular relevance is a new menu structure diagram (section 2-6) which replaces diagram 2-4 in the standard operating manual.

### 2-2 Memory idents

The receiver's memory capability is increased to 400 memories each storing frequency, mode, filter, PBS, AGC and squelch settings. Additionally each memory can store a textual identifier (up to 14 characters long) to aid station identification. A new memory editor function using the usual copy and paste operations is incorporated to make management of the frequencies and identifiers easy. Two extra features can be added to the receiver's normal operation making use of the text identifiers :-

- 1) **Ident Preview** displays the text ident for three seconds whenever a memory is selected or previewed.
- 2) **Ident Search** checks the frequency stored in all of the memories for a close match to the currently tuned frequency and, if one is found, displays the appropriate text ident for 10 seconds.

### 2-3 New timers

The clock in the receiver has been extended to include date and month, and ten, one-year timer memories have been added. These multi-timers will recall a specified receiver memory at the start time and then run the receiver for a given period allowing unattended recording of several programs from several stations.

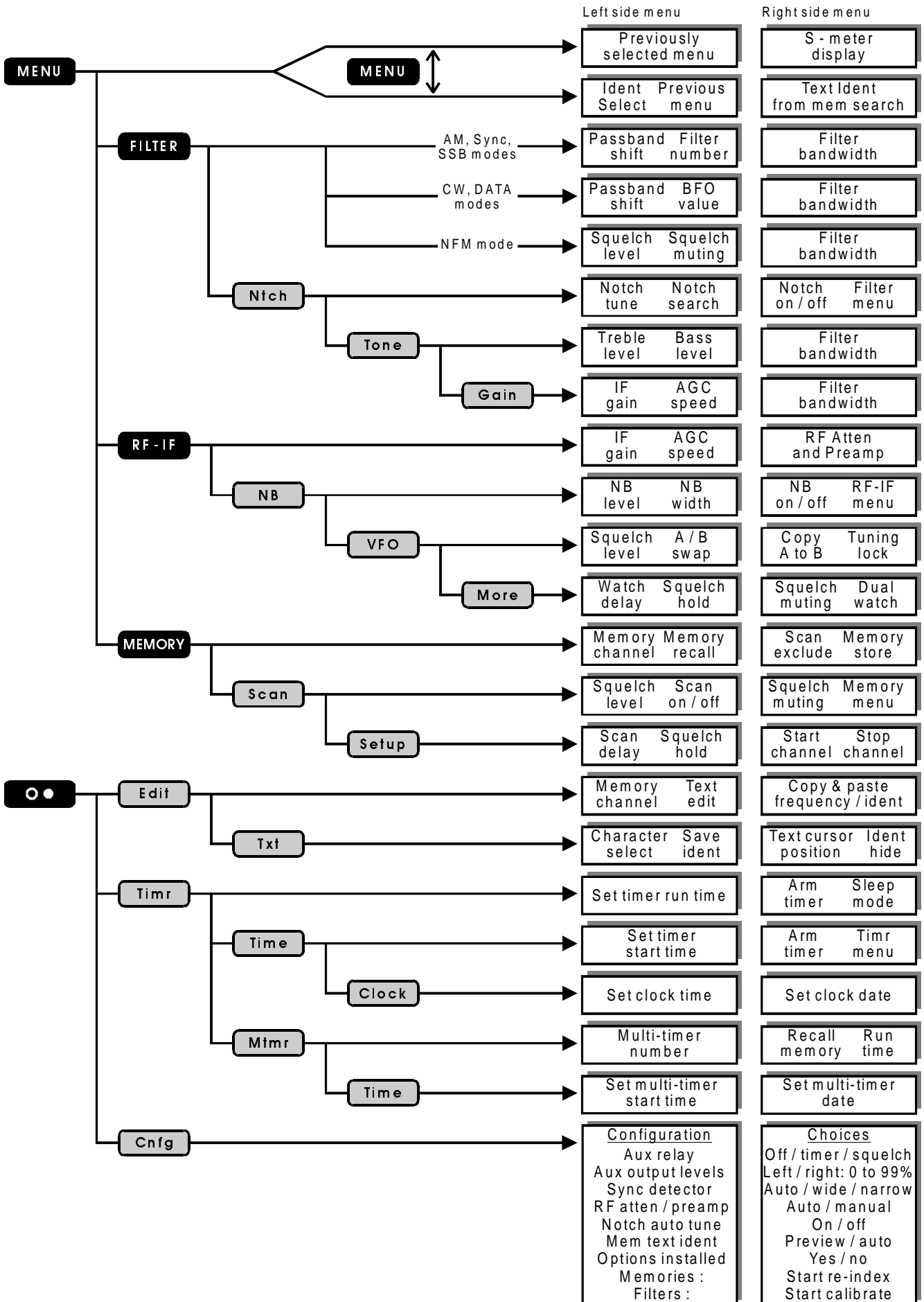
### 2-4 Noise blanker

The impulse noise blanker operates in the IF system of the receiver to reduce the effects of short-duration noise pulses. With adjustable threshold and two selectable blanking periods the NB7030 will cope with a wide range of noise and signal conditions. Most importantly, the noise blanker reduces the effect of noise spikes on the receiver's AGC system, preventing it quietening after a spike. Additional audio control circuits in the noise blanker allow successful operation in AM and Sync modes as well as SSB and CW.

### 2-5 Notch filter

The audio notch filter in the NB7030 is manually tuneable from 150Hz to 6kHz and will typically offer more than 50dB of rejection to unwanted heterodynes. A variety of automatic facilities are incorporated to make the notch quick and easy to use - the tuning rate slows down when a signal is detected close to the notch frequency reducing the chances of tuning through and missing the signal, and a signal tracking facility is available that will finish the fine tuning after coarse manual tuning. This will also track wandering heterodynes or move the notch with the receiver tuning in SSB and CW modes (provided the receiver is tuned slowly). A fully automatic notch search from 300Hz to 6kHz can be started, with the notch settling on the first steady heterodyne it finds.

## 2-6 Menu structure



### 3 Configuration menu

#### 3-1 New entries

The configuration menu is described in the AR7030 Operating Manual section 9-4. With the enhanced processor there are several new settings in the menu to cope with new options and functions.

The list of configuration settings is shown below - new items are marked ■ .

Item	Settings		
<b>Select</b>	None ( <b>Modify</b> is informative)		
■ <b>Notch auto tune:</b>	<b>Off</b>	<b>On</b>	
■ <b>Ident preview:</b>	<b>Off</b>	<b>On</b>	
■ <b>Ident auto search:</b>	<b>Off</b>	<b>On</b>	
<b>Aux relay:</b>	<b>Off</b>	<b>Timer</b>	<b>Squelch</b>
<b>Aux output muting:</b>	<b>Off</b>	<b>On</b>	
<b>Aux o/p (L):</b>	<b>0% to 99%</b>		
<b>Aux o/p (R):</b>	<b>0% to 99%</b>		
■ <b>Leap year counter:</b>	<b>0 to 3</b>		
■ <b>Notch option:</b>	<b>No</b>	<b>Yes</b>	
■ <b>NB option:</b>	<b>No</b>	<b>Yes</b>	
■ <b>RF Atten step:</b>	<b>10dB</b>	<b>20dB</b>	
<b>Sync detector:</b>	<b>Auto</b>	<b>Narrow</b>	<b>Wide</b>
<b>RF Gain:</b>	<b>Auto</b>	<b>Man</b>	
■ <b>Memory re-index:</b>	<b>Start</b>		
<b>Filter calibrate:</b>	<b>Start</b>		

Details of the settings are as follows:-

**Notch auto tune:** If turned **On** then the notch filter will centre on a signal and follow small changes in frequency. If turned **Off** then the notch filter is only manually tuned. The notch auto tune on/off setting is stored in the A, B, C Setup memories and the default is **Off**.

**Ident preview:** If turned **On** then memory text identifiers will be displayed for 3 seconds whenever memories are selected or previewed. This acts in any relevant menus where memories are involved. Preview is disabled if this is turned **Off**. The ident preview on/off setting is stored in the A, B, C Setup memories and the default is **Off**.

**Ident auto search:** If turned **On** then a memory frequency search is performed whenever tuning stops and if a match is found a text ident will be displayed. Setting this **Off** disables the automatic search but pressing the **[MENU]** button will still start the search manually. The ident auto search on/off setting is stored in the A, B, C Setup memories and the default is **Off**.

**Leap year counter:** This counter is advanced every year and is used by the clock to insert a leap day every four years. If its value is zero then February will have 29 days, so the value is best thought of as being the number of years since the last leap year. If the current year is a leap

year then the value should be zero. If necessary, use the **[RF-IF]** or **[FILTER]** buttons to change the counter value.

**Notch option:** This setting tells the receiver's control system if the notch filter menus and configuration are to be used. If the NB7030 is not installed then it should be set to **No**.

**NB option:** This setting tells the receiver's control system if the noise blanker menus and configuration are to be used. If the NB7030 is not installed then it should be set to **No**.

**RF Atten step:** Included for compatibility with future options. **MUST BE SET TO 20dB**.

**Memory re-index:** Pressing **Start** will re-index the frequency memories for the ident search operation - this takes about 6 seconds. See section 4-6 for details of when it is necessary.

#### 3-2 Setting up the NB7030 option

Two of the configuration settings are to do with the installation of the NB7030 notch filter / noise blanker option board. The **Notch option** and **NB option** settings should both be set to **Yes** if the NB7030 board is installed. If either of the settings is **No** then the menu to operate the option will not be available on the receiver's display.

To access the configuration menu, press the **[O●]** button if the Edit / Timr / Cnfg menu list is not displayed, then press the button under **Cnfg**. Use the spin-wheel to select the **Notch option** and **NB option** entries (turn the control about 1/3 turn clockwise).

Press the right menu button (under the **Yes** or **No**) to change the setting.

Config Menu settings with NB7030 installed:-

**Notch option:** **Yes**  
**NB option:** **Yes**

Config Menu settings with NB7030 absent:-

**Notch option:** **No**  
**NB option:** **No**

Press the **[MENU]** button or the **[O●]** button to return to the normal receiver display.

It is quite acceptable to have one option **On** and one **Off** if only part of the NB7030 is required. This removes the unused option menu from the receiver menu system.

#### NOTE NOTE NOTE NOTE

**Note:** If the NB7030 is **NOT** installed then setting either the **Notch option** or the **NB option** to **Yes** will result in **NO AUDIO OUTPUT** from the receiver. This condition will not be remedied with a **Default Set** operation, the only way to restore operation is to make sure that both options are set to **No**.

## 4 Memory extensions

### 4-1 More memories

Memory capacity is extended to 400 frequency memories. The extra memories are exactly the same as the first 100 except that the range of memory numbers is extended from 000 to 399. See the operating manual, section 8.

All of the memories can be selected using the spin-wheel in one of the memory menus but because it takes a long time to step through 400 memories, using the infrared controller is recommended. Memory numbers can be one, two or three digits long, leading zeros are optional. The first digit of a three digit memory number can be 0, 1, 2 or 3. If a number higher than 3 is entered, 3 will be assumed.

The memory scanning system is restricted to any group of 100 memory channels - in other words the "hundreds" digit of the memory number will not change when scanning. By allocating a few memories in each group for scanning this allows up to 4 scanning sets to be used without re-programming the scan setup.

See the operating manual section 8-4 for scanning details. The first and last scan channels are set up as described, the "hundreds" digit for the scan is taken from the current memory number - it can be changed by keying in a memory number from the infrared controller or going back to the MEMORY menu and using the spin-wheel.

### 4-2 Text identification

Each memory can have a text identification added to make selection easier and help you keep track of what is stored. Each ident can be up to 14 characters long - any characters, letters, numbers and symbols can be used. All idents are entered or changed using the memory editor.

Whenever a new frequency is stored in a memory the text ident in that memory is cleared (set to a blank ident) so that a new frequency is not labelled with an old ident. An exception - if the new frequency is within 1.5kHz of the frequency previously stored in the memory in which case the ident is left unchanged. This allows mode or filter changes or slight shifts to PBS or tuning to be made and re-stored without losing the ident text. Additionally, the store frequency operation in the memory editor does not affect any ident text so this is more suitable for changing memory frequencies when the ident needs retaining.

### 4-3 Ident preview

The idents can be displayed whenever memories are selected in which case the receiver's tuned frequency is replaced with the ident text for three seconds after the memory number is changed. Blank idents are not displayed, and the tuned frequency is re-displayed immediately if the receiver is tuned. The text ident is also displayed when the [PREVIEW] button on the infrared controller is pressed.

The ident preview facility can be turned on or off using the **Ident preview**: setting in the CONFIG menu (see section

3.1) and this setting is stored in each of the setup memories A, B and C.

### 4-4 Ident search

The ident search facility can be initiated automatically or manually. In automatic mode, whenever the receiver's frequency is changed (after tuning or a memory recall) the set searches through all the 400 memory channels for a similar frequency entry (within about 1.5kHz of the tuned frequency). If a match is found then the text ident for that memory is displayed for 10 seconds.

Idents found during a search are displayed where the s-meter is normally shown, and the ident search only operates when the s-meter is displayed (so that it doesn't obscure any menu text). The three menu buttons below the ident text operate as if the s-meter was shown.

Manual search for a matching memory is started by pressing the [MENU] button when the s-meter is displayed. Any idents found will displayed along with the memory number (at the top left) until another button is pressed. In fact the [MENU] button should be thought of as switching between s-meter and idents.



The search starts at memory 000, finds the first matching memory frequency and displays that ident. If there are several memories with the same frequency stored (for example a shared channel) the turning the spin-wheel under <ld> will cause the search to continue forwards or backwards and find any more matches. If no more are found then **No Ident** is displayed at the top left.

Pressing the [Back] button will return the left hand menu to its previous state, leaving the ident displayed. The ident will revert to s-meter if the receiver is tuned.

The automatic ident search facility can be turned on or off using the **Ident auto search**: setting in the CONFIG menu (see section 3.1) and this setting is stored in each of the setup memories A, B and C.

### 4-5 Memory editor

The memory editor is a new feature of the enhanced processor and allows memory data to be moved and copied around the 400 memories. The editor is also where text identifiers can be entered or changed.

To start the memory editor, go to the SETUP menu (press the [O●] button if necessary) and then press [Edit].



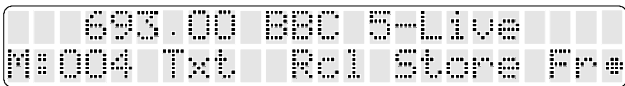
The number of the memory being edited is displayed above, and can be changed by, the spin-wheel. Its frequency and text identifier is displayed on the top line of the LCD. Memory numbers can also be entered from the infrared controller using either the [PREVIEW] or [MEM] buttons. [MEM] will recall the memory and tune the

receiver (as usual) whereas **[PREVIEW]** will just setup the new memory number in the editor.

The editor allows memory information to be copied (and moved) using the **Copy** and **Paste** operations. Pressing the **[Copy]** button duplicates all of the memory's contents in a background store (in computer parlance, a clipboard). Subsequently this information can be duplicated into a memory by pressing the **[Paste]** button, overwriting the memory contents.

The **Copy** operation always duplicates all of the stored information into the background store, but the **Paste** operation can be set to duplicate everything or just the text identifier. The right hand menu button cycles around three possibilities :-

- Id•** Duplicates only the text identifier, leaving the memory's frequency unchanged.
- F•I** Duplicates both frequency and identifier.
- Fr•** Operates on only the memory frequency, leaving ident unchanged.



In the last case the **Copy** and **Paste** legends are replaced with **Rcl** and **Store** because the memory frequency is transferred directly to and from the receiver settings - allowing mode and filters to be changed if required. If the infrared controller is used for this then there is no need to leave the editor. In the context of the memory editor, "frequency" refers to all of the stored receiver parameters - frequency, mode, filter, PBS etc.

There is no direct way to clear the contents of a memory, but if this is required then store a frequency of zero in the memory (tune the receiver to 000.00 and then use the **[STORE]** button on the infrared controller or **[Sto]** from the MEMORY menu). This will remove the memory from any ident search and scan sequence, and also clear the text identifier. If you clear several memories in this way it is beneficial to run the **Memory re-index** operation from the CONFIG menu to improve the efficiency of the ident search.

Pressing the **[Txt]** button changes to the text identifier editor.



The memory identifier is displayed with a flashing cursor which can be moved left and right using the two **< Pos >** buttons. The character at the cursor position can be changed by turning the **[Char]** spin-wheel to enter new

idents or edit existing ones. The character sequence is as follows :-

Capitals	A to Z
Symbols	[ ¥ ] ^ _ ' `
Small letters	a to z
Symbols	{   } → ← (space)
Symbols	! " # \$ % & ' ( ) * + , - . /
Numbers	0 to 9
Symbols	: ; < = > ? @

When the text identifier is complete as required pressing the **[Save]** button will write it into the memory and return to the memory editor. If you do not want to save the new ident then press the **[MENU]** button or the **[O●]** button to exit from the editor.

Text Idents can be **Hidden** which means that the ident search will not display them. This is useful if several memories have the same frequency but you only want to display one of the idents - the unwanted ones can be hidden. Ident preview ignores the hidden status.

All idents beginning with an asterisk **\*** are **Hidden**. The **[Hide]** button in the text editor will insert or remove an asterisk from the beginning of the text (but the 14<sup>th</sup> character will be lost if it is not blank).

Press the **[MENU]** button or the **[O●]** button to leave the memory editor and return to the normal receiver display.

## 4-6 Memory indexing

To enable the receiver to search all 400 memories quickly an indexing system is used where an abbreviated frequency is stored. In normal operation of the receiver the index is automatically kept up to date whenever new frequencies are stored in memories. Under certain circumstances the index update can be bypassed which means that the receiver will not be able to find matching memory frequencies. To overcome this there is a memory re-index operation (in the CONFIG menu, see section 3.1) which will index all 400 memories. This takes 5 to 6 seconds.

Re-indexing is only required when the indexes have not been updated. This will occur when a receiver is first upgraded from standard to enhanced processor - the old 100 memories are retained and incorporated into the first 100 memories of the new system. The same thing happens if the memories are downloaded from a computer using software intended only for the standard AR7030. Operating the memory re-index after the memories have been loaded will ensure correct operation.

## 5 Timer extensions

The timer and clock menus have changed slightly from those on the standard AR7030 which are shown in the operating manual. The button labels and functions are still the same, but the button positions have moved to give room for the extra timer functions.

The [+Hr] button on the TIMER menu has been removed.

### 5-1 Setting the clock time and date

The clock setting now includes date and month as well as time. See section 9-3 in the operating manual in conjunction with the following extra information.



Clk=17:39 693.00 AM  
Hrs Mins 27 Apr Back

The clock time, **Hrs** and **Mins**, are set by turning the spin-wheel, with the \* button switching between them. The date and month can similarly be altered by pressing the button below them and using the spin-wheel. After setting the date and / or month the hours / minutes display can be restored by pressing the [Hrs] button.

The date can be set between 01 and 31 irrespective of the month. Silly dates, such as 31 Apr, will be corrected at midnight when the "next" day starts.

The clock has a four-year cycle to cope with leap-years. The year counter can be set from the CONFIG menu (see section 3-1), but it is unlikely to need changing.

Pressing the [Back] button returns to the TIMER menu.

### 5-2 Timer operation

The enhanced processor provides ten Multi-timers which can operate over a 1 year period. The Multi-timers will only switch the set on from its standby state (ie with external power applied and just the clock displayed) and are ignored the set is already on or if power is not present at switch-on time.

Each timer has a memory which stores the start time and date, the running time in minutes, the receiver memory channel that holds the frequency to receive and a flag that marks it as active or not. Whenever a timer switches the radio on its flag is set to inactive so that the timer event will not happen again (a year later). All other settings in the timer remain unchanged, so to record a weekly program only the date would need editing, and the timer making active again.

The standard 24-hour timer described in the operating manual (see section 9-2 in the operating manual) will operate in conjunction with the Multi-timers provided that it is the first timer to switch the radio on. If timer operation is needed when the set is powered from internal battery then the 24-hour timer **must** be used.

The start times can be in any timer memory - the radio will automatically use the earliest time first. An **Mtmr active** message is displayed when the radio is in standby mode to indicate that one or more of the timers is active.

### 5-3 Setting the timers

To set the Multi-timers, go to the SETUP menu (press the [O●] button if necessary) and then press [Tmr] and [Mtmr] to select the MULTI-TIMER menu.



15.070.00 693.00 AM  
T:5 Time MO62 45 m Act\*

Turning the spin-wheel selects the Multi-timer memory, shown as **T:0** through to **T:9**. The receiver frequency that the timer will use is shown at the top left, along with the memory number (in the centre of the display) and the running time (in minutes). At the right of the display the **Act•** bullet shows whether the timer is active (solid bullet) or inactive (hollow bullet).

To change the receiver memory that the timer will use, press the button underneath the memory number and then use the spin-wheel or key in the number and press [MEM] on the infrared controller.



15.070.00 693.00 AM  
RxMem T:5 MO62 45 m Act\*

Similarly to set the run time, press the button under the run time display and use the spin-wheel. To return to the previous menu press the \* button under the timer memory number.

The timer start time can be set after the [Time] button is pressed.



Mtn=09:30 693.00 AM  
Hrs Mins 06 Oct Back

The start time, **Hrs** and **Mins**, are set by turning the spin-wheel, with the \* button switching between them. The date and month can similarly be altered by pressing the button below them and using the spin-wheel. After setting the date and / or month the hours / minutes display can be restored by pressing the [Hrs] button.

The date can be set between 01 and 31 irrespective of the month. Silly dates, such as 31 Apr, will not switch the set on because they will never match the clock date.

The [Back] button returns to the MULTI-TIMER menu.

Remember to check that the correct timer(s) are active before leaving the MULTI-TIMER menu by pressing the [MENU] button or the [O●] button.

## 6 Noise blanker operation

### 6-1 Option configuration

The noise blanker option has to be installed and configured before the following features and menus are available. Section 3-2 details the CONFIG menu entry for the noise blanker option. There is only this one item to set.

### 6-2 Noise blanker operation

The impulse noise blanker works by detecting rapidly rising signals (typically noise spikes) that exceed a certain threshold level and then muting the output of the receiver for a short period to remove the noise spike. Because the noise blanker uses a wider bandwidth than the other filters in the receiver it is able to apply the blanking pulse before the noise spike reaches the output and therefore remove it completely. Also because the blanking is done in the IF stages it is possible to prevent the noise from quietening the receiver by AGC action.

The trigger level for the blanker can be adjusted to suit signal conditions. If it is set too high then some noise spikes will not operate the blanker and will appear at the output. If set too low then the signal itself will be perceived as noise and some information may be lost. The default setting is 46% which is a good starting point. Adjust up or down depending on what it sounds like.

The width of the blanking pulse which mutes the signal is selectable as wide or narrow. When using SSB or CW modes this can be set to give the best results, narrow being preferable in most cases. AM and Sync modes use longer blanking pulses anyway so there is little difference between the wide and narrow settings. Again narrow is preferred.

### 6-3 Noise blanker menu

The noise blanker is operated from one menu which is inserted between the RF-IF menu and the VFO menu.

From the s-meter, press the [RF-IF] button and then the right-hand menu button which is labelled [NB].



To get to the VFO menu, the right-hand menu button can be pressed again. The RF-IF and VFO menu functions are covered in the operating manual, section 6-9 onwards.

The noise blanker trigger level is controlled by the spin-wheel in 16 steps between 0 and 99%.

The blanking pulse width is changed by pressing the ★ button below the **Wide•** bullet. The pulse is narrow when the bullet is hollow and wide when solid.

The noise blanker can be turned on and off with the [NB•] button, the bullet indicating its current state. Generally the noise blanker can be left switched on with little ill effect provided the trigger level is not too low. All noise blanker settings are retained when the receiver is switched off.

## 7 Notch filter operation

### 7-1 Option configuration

The notch filter option has to be installed and configured before the following features and menus are available. Section 3-2 details the CONFIG menu entry for installing the notch filter option. There is a second CONFIG menu entry to turn the notch auto tune facility on or off.

### 7-2 Notch filter operation

The audio notch filter in the NB7030 may be used to remove annoying whistles (heterodynes) from a received signal. It is operative in all reception modes and is designed to provide very good rejection at the notch frequency whilst making a minimal change to the quality of the signal. It can be tuned across nearly the whole of the receiver's audio spectrum from 150Hz to 6kHz.

When manually tuned, the notch tuning rate is dependent on the notch frequency. Because the notch gets wider at higher frequencies it is tuned more quickly. To speed up tuning and ensure that heterodynes are not missed the tuning rate is automatically reduced when the notch detects a steady signal near to the notch frequency. As the tuning slows an 's' is displayed after the notch frequency on the display.

The notch auto track facility uses the signal detection system to automatically centre the notch on a steady signal. Once the notch has detected a signal and manual tuning has stopped the automatic track will take over and an 'a' is displayed after the notch frequency. Manual tuning will override the auto system as soon as the spin-wheel is turned. If the notched signal is removed the auto system will disable, leaving the notch still tuned to the same frequency - this allows the auto notch to successfully remove morse code signals.

The auto track facility can be turned on or off by using the CONFIG menu entry **Notch auto tune:** (see section 3-1). This setting is held in the setup memories (see operating manual section 9-1) and is set off by default. The notch frequency is not saved when the receiver is switched off.

Completely automatic notch tuning is achieved with the notch search facility. This is started manually by pressing the [Srch] button whereupon the notch searches for any steady signals starting at 300Hz up to the top limit of 6kHz. The filter will notch out the lowest frequency signal it finds and then returns to manual tuning mode (so a different notch frequency can be selected if needed). In the event of multiple heterodynes it is usually best to remove the high frequency ones with the IF filter bandwidth and passband shift facilities and then use the notch to take out the low frequency signal. The notch will only remove one signal, so choose the most annoying one if there are several.

### 7-3 Notch filter menu

The notch filter is operated from one menu which is inserted between the FILTER menu and the TONE menu.

From the s-meter, press the [FILTER] button and then the right-hand menu button which is labelled [Ntch].



To get to the TONE menu, the right-hand menu button can be pressed again. The FILTER and TONE menu functions are covered in the operating manual, section 6-6 onwards.

The notch filter frequency is controlled by the [Ntch] spin-wheel and the frequency is displayed in kHz at the top left. Annunciators after the frequency can show either 's', indicating slow tuning, or 'a', indicating auto tune is active.

The notch filter can be turned on and off with the [Nch•] button, the bullet indicating its current state. The filter is switched on if the notch frequency control is rotated or if the [Srch] button is pressed, so the [Nch•] button will generally only be used to turn the filter off. The filter defaults to off when the radio is switched on.

Auto search is started by pressing the \* button below **Srch**. When the search is running the >>>> symbol appears to the right of the notch frequency. When a steady signal is found the search will stop and the notch will auto tune onto the signal. The search symbol >>>> will then disappear. If no signal is found the notch filter is switched off and its frequency returned to 1kHz.

### 8 Option specifications

Performance figures relate to a typical production NB7030 and are not guaranteed values. Specification subject to change due to continuous development of the receiver and its accessories. E&OE

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#### Notch Filter

Tuning range:	150Hz to 6.0 kHz digitally tuned.
Filter type:	4-pole switched capacitor notch.
Notch depth:	> 40 dB, typically >50dB over most of the tuning range.
Notch shape:	At 1kHz >10Hz wide at -40dB <100Hz wide at -6dB
Facilities:	Auto slow tuning on signal Auto fine tune / signal tracking Auto search for tone

#### Noise Blanker

Threshold:	Adjustable 0 to 20dB above mean signal level.
Input range:	> 80dB
Blanking period:	Narrow 1.5ms SSB and CW modes. 8ms AM and Aync modes. Wide 6ms SSB and CW modes. 12ms AM and Aync modes.
Bandwidth:	15kHz noise detection bandwidth.
Gating:	SSB & CW Balanced IF gate after narrowest 2 <sup>nd</sup> IF filter. AM & Sync IF gate and slow slope audio attenuator.